Proposal:

An IPS – Intelligent Parking System

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I. Abstract

This design project is for a parking system that will contain a magnetic sensor in order to detect a vehicle presence in a parking spot. Once the car has been detected in the spot a vehicle identification process will begin. There are two distinct ways that a car can be identified and given the okay to be able to park in a spot. Those two ways are though a RFID (Radio Frequency Identification) with a tag being on the car and a reader either on the wall or on the ground to identify the RFID tag which will then give the car authentication to park in the spot through that process. Another way of granting authentication to park in the spot is through a keypad and LCD terminal. If an important visitor or speaker is coming to the building you should be able to grant him/her access through a code that can be entered on the keypad of the parking system. These two authentication methods allow everyday users the right to park easily and give visitors to an opportunity to get close parking without much hassle. This system of vehicle detection along with RFID and Keypad will be run on an embedded web server device. This embedded web server will have a webpage that will be able to keep track of who is in what spots, grant key codes for visitors, and give a notice of when someone is not supposed to be parking in the area. All these components will come together to create an intelligent parking system.

II. Problem Definition

1. Problem

   Parking spots in the back of the Engineering building at SDSU want to be utilized to its fullest potential. A system needs to be designed that will cover all possibilities of the spots actually being used.

2. Assess Costumer Needs

   This problem exists because these parking spots are not allocated to anyone particular person. Essentially these spaces exist but are not allowed to be used in any orderly way. Therefore it is our group task to design a system that will fix this and open up these spots to certain individuals. In order to accomplish this, an intelligent parking system (IPS) will be created to recognize and give authentication to certain cars. The task of the IPS is to be able to detect if there are cars in particular spots. If a car exists in a spot then the parking system should be able to recognize the car and then be able to authenticate the car. There are two authentication processes that will be used in the design. Before we can authenticate the car, we need to first be able to detect the car by using a magnetic sensor. This sensor should detect the car when the car pulls up. After the car has been detected either an RFID tag will be read and then permit the vehicle to park in the spot or a keypad with an LCD screen will be used for authorization. The keypad verifies a special code that will be given out to visitors of the building or special guests. A

sensor module will be created to detect the car, check for a RFID, and perform keypad activation for a spot. Once this is done it will send information to the embedded web server which will be service a webpage displaying the status of the parking spots and whether a user is allowed to park there or not. The webpage will also indicate by which authorization method they were allowed to park there. A wired connection will exist for the two modules to be able to communicate with each other. Thus allowing an administrator to monitor the parking spots at all times by using IPS.

3. Functionality

    - Be able to detect a car when it pulls into a parking spot behind the Engineering SDSU building.
    - Authentication Process of the car in the parking spot
        - RFID tag read by a RFID reader that gets sent to the main module for authentication.
        - LCD/Keypad code to be entered that will get sent to the main module with the web server to get authenticated to park in the spot.
    - A web server that manages the IPS
    - I2C wired communication between the sensor and main modules
    - A dynamic system with one main module (web server), with as many sensor modules as needed. Can add modules as needed.

4. Conceptual Design

    There will be two modules in this design, a sensor and a main. The IPS will have three physical boxes so to speak. The main module will be in a box with only inputs and outputs with the web server nestled in the box. The sensor module will have two parts to it, first the box with the magnetic sensor and the RFID reader that will send a signal out to the main module. The second part of the sensor module will also have the LCD/Keypad coming off it with a pure digital signal getting passed between the two using the A/D converter in the microcontroller in the sensor module to send the signal. Please see Figure 1.

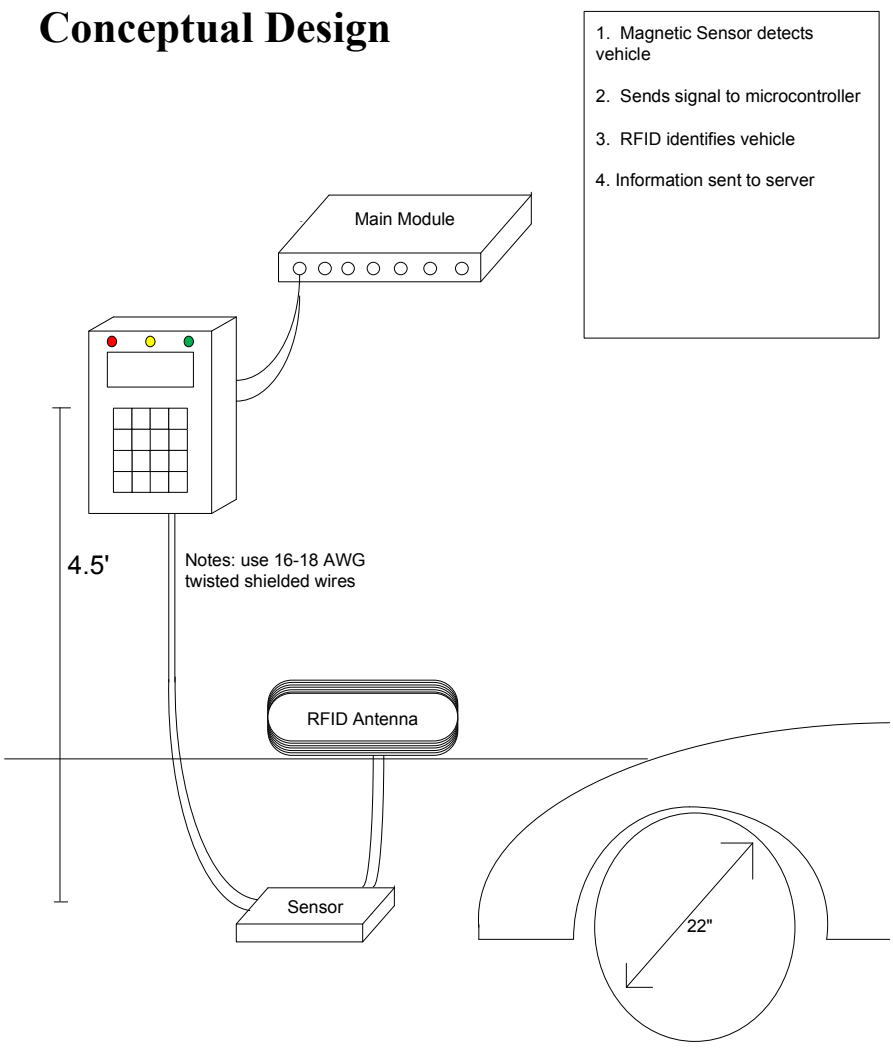


Figure 1: Conceptual Design

II. System Design

1. Background Research

Most of the background research that we did was related to other existing products out there in the market today. Many of those products that we saw were similar things that we wanted to accomplish in our product. For instance, many of the existing technologies that are out in the market use Radio Frequency Identification (RFID) to authenticate and authorize entry into a parking lot or a parking space. Antennas are often used to increase the range of the RFID reader, but from our research, not much more range can be obtained by use of an antenna.

Also, keypad entry is used for authentication as well for many of the similar systems that are out on the market today. A user would step up to a module that houses a keypad entry and would be asked to enter an access code for access to the parking lot or parking spot. A system that we also ran into in our research had to do with license plate recognition and comparing images of a license plate within a database to a picture that is taken with a camera to authenticate the user of the parking spot. Our group however did not want to take our project in that direction.

2. Functional Diagram (Block)

   See Figure 2 and 3

3. Identify Constraints

   i. Economic

   In the design of our Intelligent Parking System (IPS), we are concerned with the target cost of the product. We hope to deliver a product that is affordable and convenient. Our target design is going to consist of donated and inexpensive parts to keep the cost down to a minimum. We hope to deliver a working product by spending $250 or less on parts alone. We will make three modules consisting of a control module, a sensor module, and a module to house the sensors. We will go cheap by not paying the price to get innovative technology. Instead, we will take the more inexpensive technology and expand on it to improve it ourselves. Then again, we will not turn down a piece of hardware if it's going to be donated. Our plan is to let the consumer buy a main control module to control a dynamic array of sensor modules. Then, the consumer can add on sensor modules as needed.

   ii. Environmental and Social Factors

   The new parking system will be installed in the parking lot that is in the back of the Engineering building at SDSU. It needs be able to withstand extreme temperatures ranging from 29° F to 111° F. The IPS sensor modules will be durable against all forms of precipitation. IPS will monitor these parking spaces 24 hours a day and thus will be constantly active. Therefore the modules need to be able to hold up over time and not need new parts frequently. Also the system will need to well manufactured and resilient to vandalism and theft.

   iii. Standards and Legislation

   Using RFID as an authentication system, there are several standards which are published and regulated by the ISO (International Organization for Standardization) depending on a frequency range and an application of RFID.

However, according to Wikipedia, there is no universal organization that governs the frequencies used for RFID and as a result; every country has its own rules for this. In USA, FCC (Federal Communications Commission) has an authority over RFID frequencies.

In this project, we will be using RFID which will be operating in Low-frequency (LF) ranging from 125 to 134.2 kHz. ISO has set standards both for RFID tags that are ISO/IEC 15963:2004 and RFID air interface communications below 135 kHz that is ISO/IEC 18000-2:2004.

"ISO/IEC 15963:2004 describes numbering systems that are available for the identification of RF tags. A unique ID is required as part of the write operation to RFID tags. The unique ID guarantees that the information written to a tag is unambiguously written to the correct data carrier (tag). A unique ID is also required in many read situations where the contents of the tag are tied to a specific item and that item needs to be unambiguously identified. The unique ID may also be used for the traceability of the integrated circuit itself for quality control in their manufacturing process; for the traceability of the RF tag during its manufacturing process and along its lifetime; for the completion of the reading in a multi-antenna configuration; by the anti-collision mechanism, to inventory multiple tags in the reader's field of view; for the traceability of the item to which the RF tag is attached."

"ISO/IEC 18000-2:2004 defines the air interface for radio-frequency identification (RFID) devices operating below 135 kHz used in item management applications. Its purpose is to provide a common technical specification for RFID devices to allow for compatibility and to encourage inter-operability of products for the growing RFID market in the international marketplace. ISO/IEC 18000-2:2004 defines the forward and return link parameters for technical attributes including, but not limited to, operating frequency, operating channel accuracy, occupied channel bandwidth, spurious emissions, modulation, duty cycle, data coding, bit rate, bit rate accuracy, bit transmission order. It further defines the communications protocol used in the air interface."

iv. <u>Maintainability</u>

Not much has to be done to keep this system maintained. To keep the system maintained, the database must be maintained and kept updated, as the database is capable of expanding with the number of spots that the system administrator would like to manage. The sensors must be maintained as well, to make sure that the sensors can detect whether a car is in a parking spot. Make sure that the system is not exposed to water, as there are various electric devices within the parking spot module and the main

module. Also, make sure that the network cable is connected, otherwise the connection between the parking spots and the main module will be terminated and communication between the two modules will be nonexistent.

v. Serviceability

As the electronic components are utilized, the user needs to properly handle these items to protect the components and users involved. Services will have to be made to the web server as needed to fix any inconsistencies that may occur after set up. The sensor module will have to be monitored from time to time also to make sure all the components still are working properly. Replacements may be needed as the components start to wear after time.

vi. Manufacturability

The sensor module must hold all the hardware pieces securely without rattling around. It will need to hold all the components in a way that is secure and allows it to detect and read the car as needed. It will need to be mounted in a way that will receive physical damage when the car pulls up, as well as being close enough for the RFID reader to read a tag and the magnetic sensor to be able to detect the car. The main module will also hold hardware components that should be secure and in a safe place were no damage will occur.

III. Project Plan

1. Task Decomposition

i. Block Diagram (Hardware)

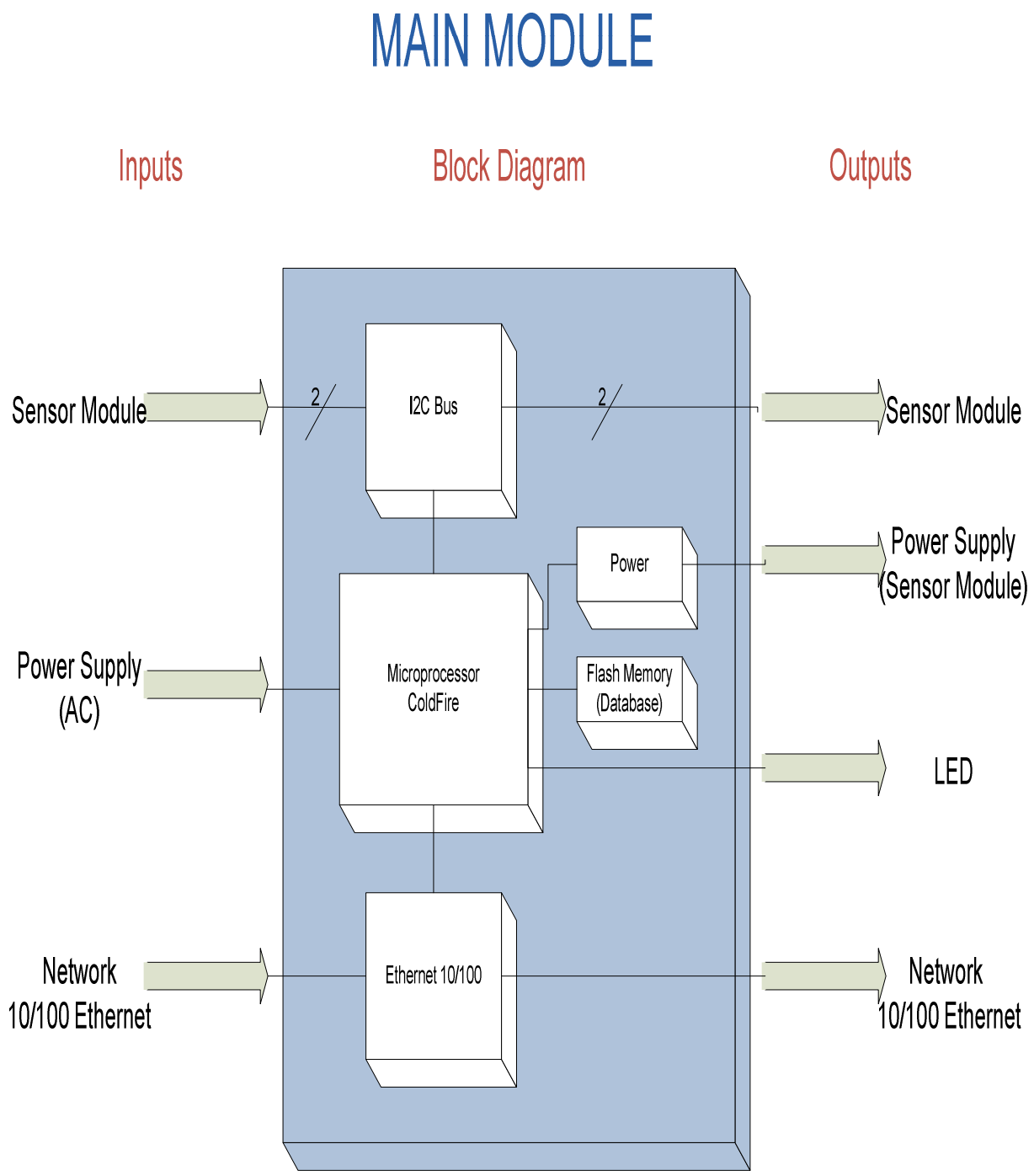


Figure 2: Main Module Block Diagram

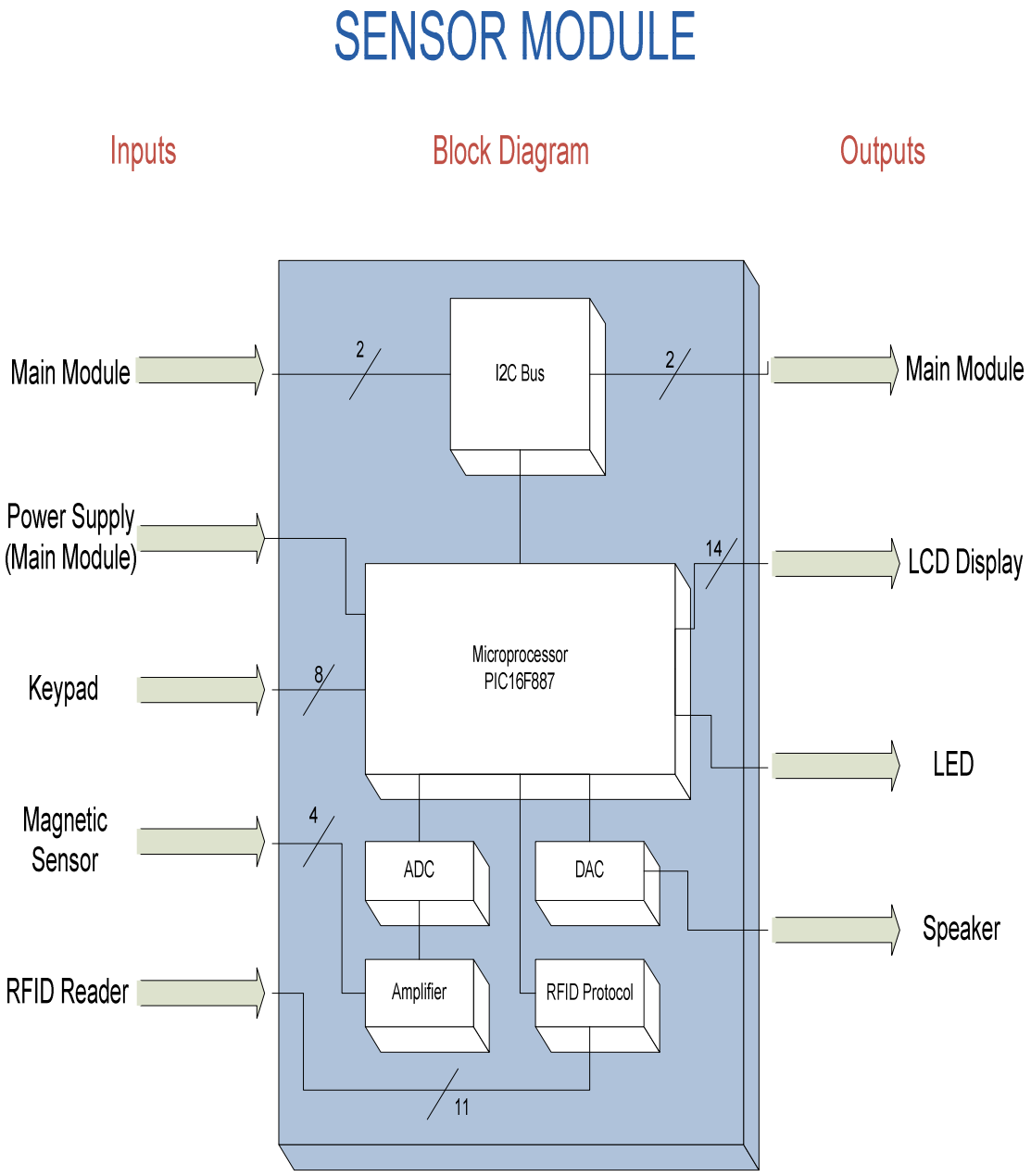


Figure 3: Sensor Module Block Diagram

ii. State Diagrams

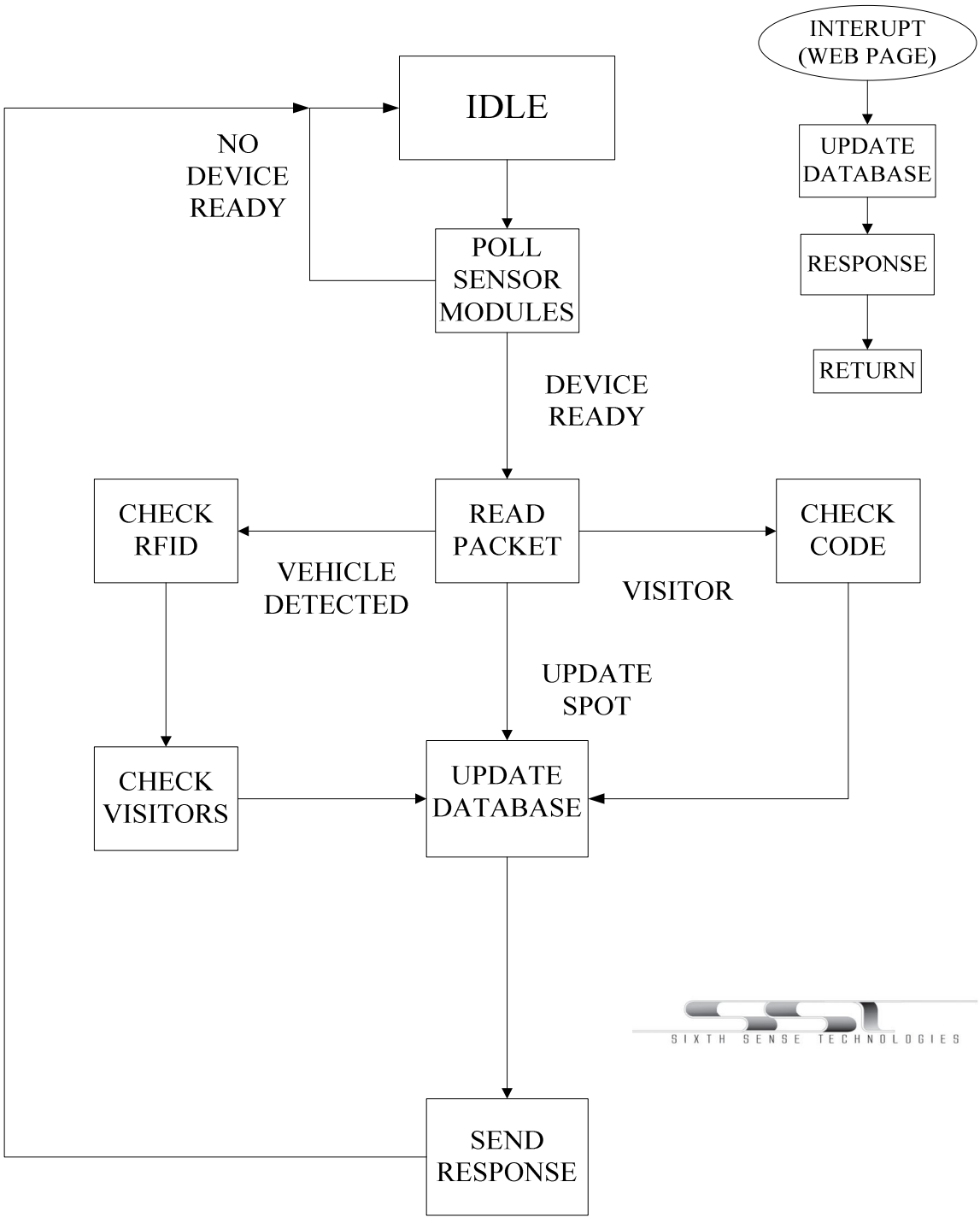


Figure 4: Main Module State Diagram

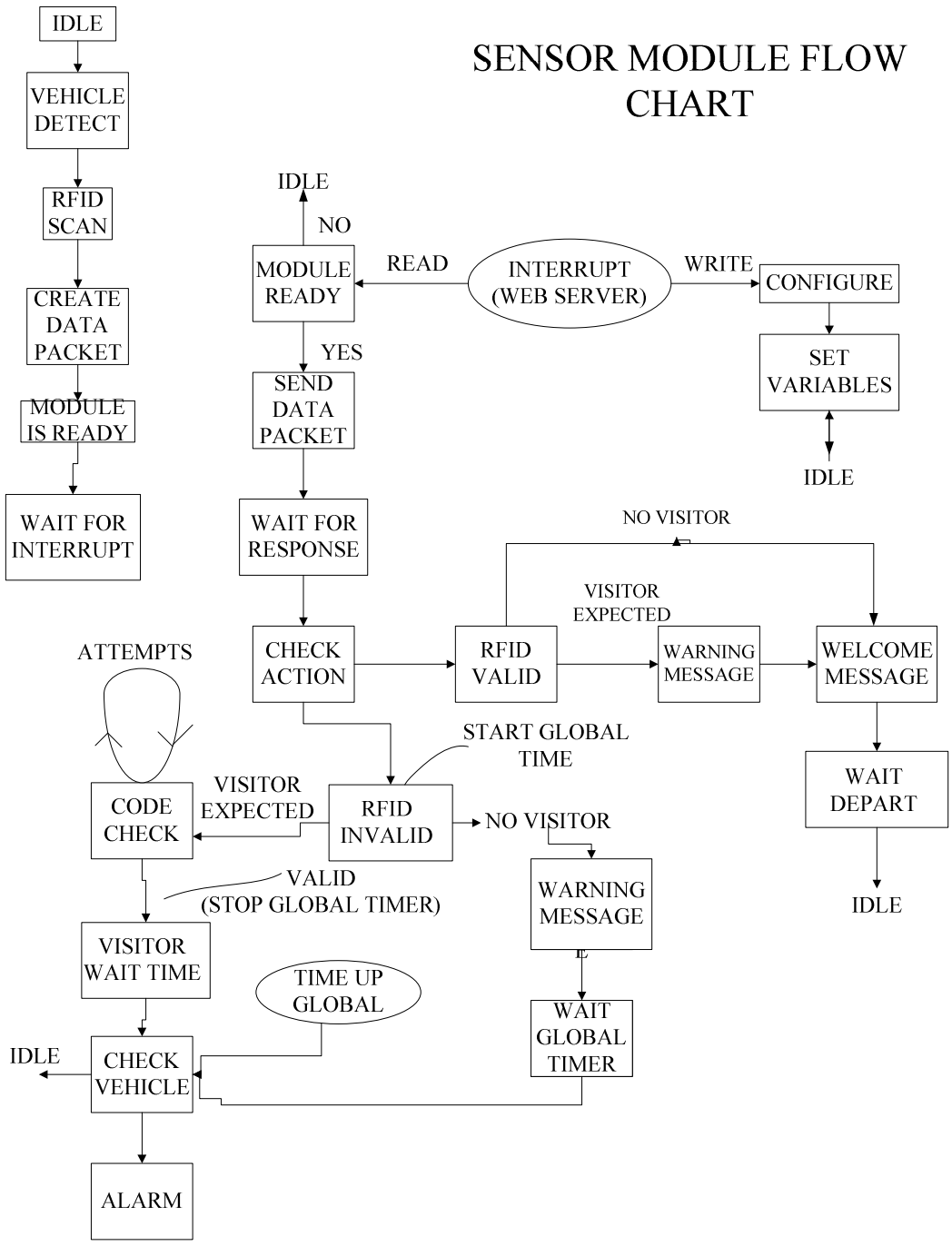


Figure 5: Sensor Module State Diagram

2. Task Schedule

The task schedule will consist of a sequential process of multiple responsibilities among team members. We have already done our homework in

researching the necessary technologies to make this project successful. We will start out by working with the sensors and make them do what they are supposed to do. While that is being worked on, we can also start on the web interface and database for the control module. Also, in order to utilize the time efficiently, we can start programming the microcontroller to interface a keypad and LCD. Once done, we can move forward to interface the sensors to the microcontroller and process its data. The main control module can now be worked on to integrate user actions on the website to actual I/O functions and operations. Next, we will be able to work on the communication protocol between the sensor and main control modules. We will be implementing a protocol, I2C, for all the data communications in a daisy chain format with the control module being a master and all successive sensor modules as slaves. Once we reach a successful communication, we can begin to test and debug the whole system. We will try to schedule everything very strictly by making deadlines be reasonable and quick. Since it never goes as planned, this will allow for setbacks and not really hurt our production.

3. Project Management

   i. Individual Responsibilities

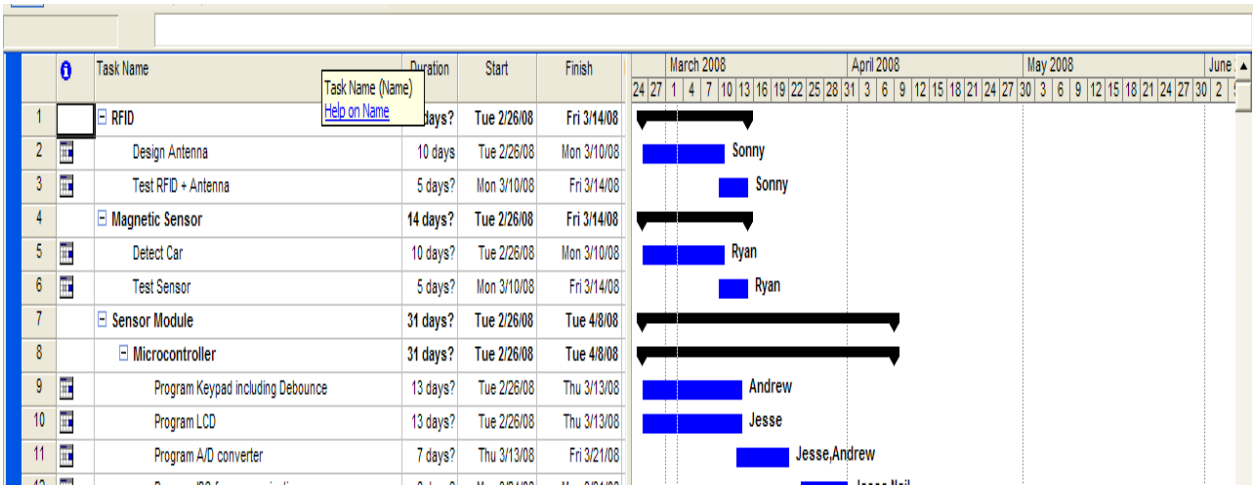
      Since our team consists of six members, we plan to utilize the allotted time in an efficient manner. Each member will be responsible of a certain expertise in their field. In addition, they will be given opportunities to research and develop technologies in their interest. According to our Gantt chart, you can see what everyone's responsibilities will be. To summarize here, our Electrical Engineers, Sonny Tjahyadi and Ryan Santos, will be responsible on the RFID reader and magnetic sensors, respectively. Sonny is going to work on fabricating an antenna for the RFID reader in order to reach the required distance. Ryan will get the magnetic sensor to detect a car in the parking space by making sure the sensor will give us the necessary voltage swing to sample. The person specializing in the PIC16F887 microcontroller will be Jesse de la Rosa. His responsibility will be to interface and process the RFID and sensor signals to the microprocessor. Also, he will work with Andrew Cabalfin in programming the PIC microcontroller and also interface the keypad and LCD display. Andrew's responsibility, in addition to the microcontroller, will be to design and maintain the company's website. Last, but not least, Neil Leonora and Mark Goodburlet will be responsible on designing the main control box. This mainly consists of an embedded web server with an onboard Freescale microprocessor. Neil's main responsibility is to interface the I/O with the user's commands by programming the website and microcontroller. Mark is to also help with the website by creating the user interface and also create the database to store information about authorized individuals allowed to park in the specified spaces.

ii. Monitoring and Reporting

In addition to our scheduled meetings every Tuesday, we are taking it upon ourselves to meet additionally on Mondays, Thursdays, and Sundays every week. This will allow us to interact with everyone and keep everyone updated on our progress. Our goal is to not have any time wasted. We have a few months to work on this, so we are going to make sure we use the time efficiently and not fall behind. During our weekly meetings we are to report to the whole team on each other's progress and/or problems. Everyone will be free to work on their part of the project at anytime and the deadlines will be up to them to be met just as long as the whole team is kept in the loop of their progress.

iii. Task progress and Schedule status

As our product develops, we are going to run into problems that may put us behind. This is why Jesse has devised a schedule that will keep us ahead of schedule and to take into consideration of fall backs we may have, but it shouldn't put a big dent in our progress. Everyone is not limited to their own task. They are free to work with each other and help them out. Some of the schedules in the Gantt chart may be more or less time needed. The team is to use the time efficiently by helping out others in need when they are done with their own task. The schedule will be updated every time there is a task met before or after the deadline. Our schedule is strict and should be followed with excellent time management. If we follow our plan accordingly, we should finish the product with fewer hassles.



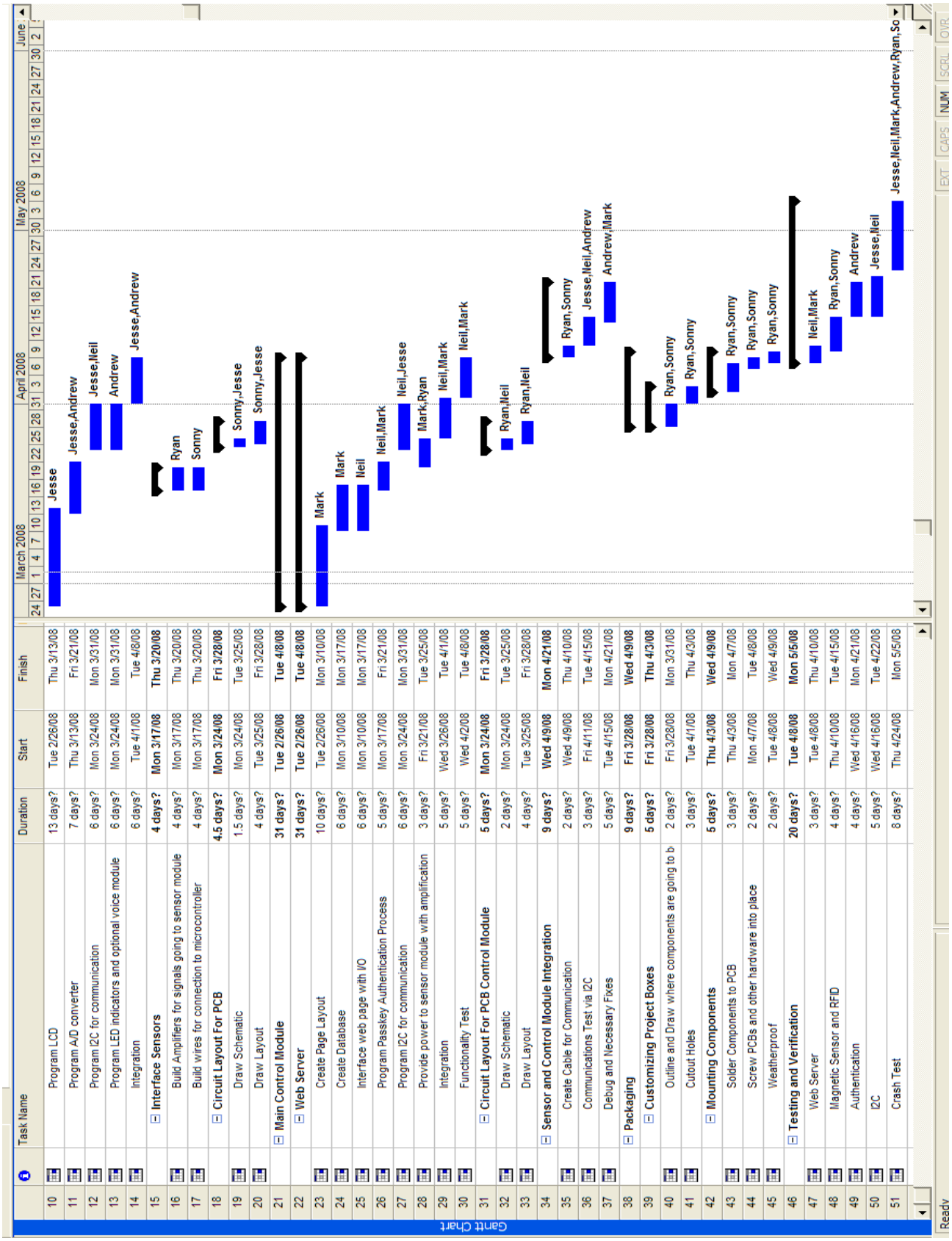


Figure 6: Gantt chart Representation

IV. Budget

Description		Cost
Engineers and Development Cost		
6 Engineers (3360 hours) @ $50.00/hour		$168,000.00
Parts and Components		
Sensor Module:		
RFID Module ID12	$29.95	
RFID Tag	$1.95	
RFID Antenna	$0.00	
Magnetic Sensor	$50.00	
LCD Display	$20.00	
Keypad	$3.00	
Speaker (Maybe)	$0.00	
PIC Microcontroller	$2.04	
Main Module:		
Embedded Web Server - Netburner MOD5270	$99.00	
Flash Memory	$10.00	
Power Supply	$5.00	
LEDs	$5.00	
Resistors and Capacitors	$5.00	
PCB Boards	$5.00	
Enclosures	$10.00	
Serial Cables	$3.00	
Total Parts and Components		$248.94
TOTAL COST		**$168,248.94**

Figure 7: Budget Proposal

V. References

http://en.wikipedia.org/wiki/RFID

http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=30530

http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=34113

http://www.microchip.com (For the 16F887 Chip)

http://www.sparkfun.com (For ideas and sensors)

http://www.seniordesignlab.com (For links to various sites)

MPLAB IDE v8.00 (For coding the main panel)

http://www.netburner.com (For Embedded Web Server)